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Opinion
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An engineering Approach for 3-D Numerical Earthquake Analysis

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Opinion

This approximate calculation method is developed and designed for replacement of the arbitrary Non-Linear Push-Over (NLPO) method. The proposed rational methodology is an intermediate engineering approach between the Linear-Elastic Dynamic Modal Response Spectrum method and Non-Linear Dynamic Time Domain (History) method and comprises six steps, i.e.

A. Step 1

Perform a numerical 3-D Linear-Elastic Dynamic Modal Response Spectrum calculation based on the relevant Horizontal Elastic Ground Acceleration Response Earthquake (Seismic) Spectrum (input). Utilize the Complete Quadratic Combination (CQC) method instead of the Square-Root-of-Sum-of-Squares (SRSS) method. Because it is well-known for a long era that application of the Square-Root-of-Sum-of-Squares (SRSS) method in seismic analysis for combining modal maxima can yield significant errors.

B. Step 2

Extract the numerically determined (calculated) total component support reactions F_X, F_Y and F_Z. A global Cartesian (X, Y, Z components) right-handed coordinate system is adopted.

C. Step 3

Resolve the numerical calculated mass of the structure $m_{structure}$. It is tacitly assumed that the sum of the effective (participating) modal masses for the vibration modes taken into account amounts to 100% of the total mass of the structure, i.e. $m_{effective\ (participating)\ modal\ mass} = m_{structure}$.

D. Step 4

Calculate the Cartesian component accelerations. $a_X = F_X / m_{structure}$, $a_Y = F_Y / m_{structure}$ and $a_Z = F_Z / m_{structure}$.

E. Step 5

Execute a numerical 3-D Non-Linear (Physical and Geometric) Static calculation with the retrieved Cartesian component accelerations a_X, a_Y and a_Z.

F. Step 6

Compare the acquired numerical results with a conventional (EUROCODE) 3-D Non-Linear Push-Over (NLPO) earthquake calculation method and 3-D Non-Linear Dynamic Time Domain (History) (NLTH) calculation [1-4].

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